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Infant Symbolic Play as an Early Indicator of Fetal Alcohol-Related Deficit

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Abstract

Infant symbolic play was examined in relation to prenatal alcohol exposure and socioenvironmental background and to predict which infants met criteria for fetal alcohol syndrome (FAS) at 5 years. 107 Cape Coloured, South African infants born to heavy drinking mothers and abstainers/light drinkers were recruited prenatally. Complexity of play, socio-demographic and psychological correlates of maternal alcohol use, and quality of parenting were assessed at 13 months, and IQ and FAS diagnosis at 5 years. The effect of drinking on spontaneous play was not significant after control for social environment. By contrast, prenatal alcohol and quality of parenting related independently to elicited play. Elicited play predicted 5-year Digit Span and was poorer in infants subsequently diagnosed with FAS/partial FAS and in nonsyndromal heavily exposed infants, compared with abstainers/light drinkers. Thus, symbolic play may provide an early indicator of risk for alcohol-related deficits. The independent effects of prenatal alcohol and quality of parenting suggest that infants whose symbolic play is adversely affected by alcohol exposure may benefit from stimulation from a responsive caregiver.

Keywords

fetal alcohol syndrome; symbolic play; parenting; HOME Inventory; prenatal alcohol exposure

Development of Symbolic Play in Alcohol-Exposed Infants in Cape Town, South Africa

Although the longterm adverse effects associated with fetal alcohol exposure are well known and numerous psychosocial interventions have been attempted, many women continue to drink heavily during pregnancy, and identification of affected infants is difficult. As many as 13% of infants born in the U.S. are exposed to varying levels of alcohol during pregnancy, with higher rates found among disadvantaged populations (CDC, 2002).

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Descriptive studies spanning three decades have identified a broad range of neurocognitive and behavioral deficits in children with fetal alcohol spectrum disorder (FASD). FASD ranges from the most severe, fetal alcohol syndrome (FAS), which is characterized by a distinctive craniofacial dysmorphology, small head circumference, and pre- and/or postnatal growth retardation, to children with alcohol-related neurodevelopmental disorder (ARND), who exhibit significant cognitive impairment but lack the distinctive facial anomalies (Hoyme et al., 2005). Children with FASD exhibit deficits in diverse domains, including verbal IQ (Jacobson, Jacobson, Chiodo, Sokol, & Corabana, 2004); arithmetic (Streissguth, Barr, Carmichael-Olson, Sampson, Bookstein, & Burgess, 1994; Goldschmidt, Richardson, Stoffer, Geva, and Day, 1996; Jacobson et al., 2004; Howell, Lynch, Platzman, Smith, & Coles, 2006); and executive function (Coles, Platzman, Raskind-Hood, Falek, & Smith, 1997; Kodituwakku, Handmaker, Cutler, Weathersby, & Handmaker, 1995). Although objective criteria have been developed to diagnose the facial anomalies and growth retardation associated with FAS in pre-school and school-age children, the facial dysmorphology is difficult to identify in infants and the cognitive and behavioral deficits are nonspecific.

Neurobehavioral deficits of prenatal alcohol exposure have been linked to the Bayley Scales of Infant Development in several studies (Golden, Sokol, Kunhert, & Bottoms, 1982; Jacobson, Jacobson, Sokol, Martier, Ager, & Kaplan-Estrin, 1993a; Streissguth, Barr, Martin, & Herman, 1980). In the Detroit longitudinal alcohol exposure study, an attempt was made to identify specific neurobehavioral biomarkers of fetal alcohol exposure by administering a series of narrow-band infant tests, and elicited symbolic play emerged as one of the most sensitive and specific endpoints (Jacobson et al., 1993). This study used the Belsky, Garduque, and Hrncir (1984) 14-level standardized measure of infant play development to assess spontaneous play, the level the infant exhibits during free play, and elicited play, the highest level the infant exhibits when attempting to imitate the examiner. By analogy to language development, the highest level of spontaneous play indicates the child's performance level. Based on the assumption that the infant cannot imitate a behavior that s/he does not understand and cannot assimilate, the highest level of play elicited by the examiner can be considered to indicate the child's competence.

Few studies have examined the influence of both socioenvironmental and pre- and perinatal risk factors on the development of symbolic play in infancy. The most important socioenvironmental influences on development include familial socioeconomic status, maternal education, quality of intellectual stimulation provided by the parent, and maternal intellectual competence, stress, and depression. In the Detroit longitudinal study, which focused on infants born to women who drank at moderate-to-heavy levels during pregnancy, prenatal exposure was inversely correlated with performance on both spontaneous and elicited play (Jacobson et al., 1993). After controlling for potential confounding socio-environmental influences, however, only the relation with elicited play remained significant, suggesting that fetal alcohol exposure directly affects the infant's capacity to acquire increasingly complex symbolic manipulations by modeling adult behavior, the component of play considered to represent the infant's competence level (Belsky et al., 1984). Moreover, elicited play was not related to prenatal exposure to smoking, cocaine, or marijuana. In addition, elicited play at 1 year was moderately predictive of Verbal IQ at 7.5 years (Jacobson, Chiodo, & Jacobson, 1996), suggesting that it may constitute a meaningful precursor of verbal development.

Recent studies have documented a very high prevalence of heavy alcohol use during pregnancy (Croxford & Viljoen, 1999; Jacobson et al., 2008) in the Cape Coloured (mixed ancestry) population in the Western Cape province of South Africa, where the incidence of FAS is 18 to 141 times greater than in the U.S. and among the highest in the world (May et

al., 2000). This population, composed mainly of descendants of white European, Malaysian, Khoi-San, and black African ancestors, has historically comprised the large majority of workers in the wine-producing and fruit-growing region of the Western Cape. The high prevalence of heavy drinking is attributed to the traditional *dop* system, in which farm laborers were paid, in part, with wine. Although the *dop* system has been outlawed, heavy alcohol consumption continues to be prevalent in urban and rural Cape Coloured communities (Carter et al., 2005; Jacobson et al., 2006), and weekend binge drinking is a major source of recreation for many in the community.

Given that FASD frequently occurs within the context of a high-risk environment, it is important to distinguish between the harmful effects of prenatal alcohol exposure and the additional impairment that may result from being reared in an environment in which the mother or both parents drink heavily. This South African sample offers the opportunity to replicate the previous findings from the Detroit study and to attempt to further disambiguate the alcohol effects from potentially confounding socio-emotional concomitants of being raised by a drinking mother. The second focus of the study was to examine the degree to which symbolic play in infancy provides an early indicator of fetal alcohol-related impairment, as indicated by FAS diagnosis and verbal competence in childhood. FAS diagnosis was deferred until age 5 years because this syndrome is difficult to diagnose during infancy except in the most severe cases. The assessment at age 5 also provided an opportunity to confirm the previous Detroit finding that elicited play provides an early indicator of effects of prenatal alcohol exposure on verbal ability in childhood.

The aims of this study are (1) to examine which aspects of the infant's social environment appear to most strongly influence the early development of symbolic play; (2) to test the hypothesis that, as in Detroit, prenatal alcohol exposure will be specifically associated with poorer competence in symbolic play, as indicated by the elicited play measure; (3) to examine the degree to which symbolic play in infancy is predictive of verbal competence at 5 years of age; and (4) to examine the degree to which infant symbolic play can be used to discriminate infants subsequently diagnosed at 5 years as having FAS or alcohol deficits from those who were heavily alcohol exposed but did not meet criteria for the syndrome.

Methods

Sample

The sample of 107 infants (57 males and 50 females) and their mothers was drawn from a cohort of 159 Cape Coloured women living in Cape Town, South Africa, who are participating in a prospective study on the effects of heavy prenatal alcohol exposure on neurobehavioral development. The mothers were recruited between July 1999 and January 2002 from the antenatal clinic of a midwife obstetric (MOU) unit that serves an economically disadvantaged Cape Colored community (Croxford & Viljoen, 1999).

The sample includes 66 heavy drinking mothers and 41 light drinkers and abstainers who were recruited during the same period by our research nurse. Antenatal care was initiated at 19.1 weeks gestation on average (range = 6.0–34.0 wk). Each mother was interviewed during her initial antenatal visit to the MOU regarding her alcohol consumption both at the time of conception and at time of recruitment, using an interview derived from the timeline follow-back approach (Sokol, Martier, & Ernhart, 1985) used in the Detroit longitudinal alcohol exposure study (Jacobson, Chiodo, Sokol, & Jacobson, 2002). Any woman averaging at least 1.0 oz per day (AA/day), the equivalent of two standard drinks, or reporting at least two binge drinking episodes (five standard drinks per occasion) during the first trimester of pregnancy was invited to participate in the study. Women initiating

antenatal care at this clinic who drank less than 0.5 oz AA/day and did not binge drink during the first trimester were invited to participate as abstainers/light drinkers.

Women < 18 years of age and those with diabetes, epilepsy, or cardiac problems requiring treatment were not invited to participate. Religiously observant Moslem women were also excluded because their religious practices prohibit alcohol consumption. Infant exclusionary criteria were major chromosomal anomalies, neural tube defects, multiple births, and seizures. Informed consent was obtained from each mother at recruitment and at the first laboratory visit. Approval for human research was obtained from both the Human Investigation Committee at Wayne State University and the Ethics Committee at the University of Cape Town (UCT) Faculty of Health Sciences. The 107 infants and mothers included in this study of effects on symbolic play are all those for whom complete data were available on the 17 prenatal alcohol exposure, play, and socio-demographic variables examined here. All women who reported drinking during pregnancy were advised to stop or reduce their intake, and exposed and control mothers were invited to participate in a home visitor intervention.1

Procedure

The mother and child were transported by a staff driver and research nurse at 6.5, 12, and 13 months and 5 years to our laboratory at the UCT Faculty of Health Sciences, where the maternal interviews and neurobehavioral assessments were performed. At 5 years they were also transported to the FASD diagnostic clinic, which was held at a neighborhood church. Each mother was re-interviewed antenatally and at 1-month postpartum regarding her pregnancy alcohol and drug use. Interviews were conducted in Afrikaans or English, depending on the mother's preference. Each mother-infant dyad was provided breakfast prior to the assessments and interviews. All infant assessments were conducted and coded by research staff who were blind with respect to maternal alcohol use and group status; all maternal interviews including the HOME were conducted by a developmental pediatrician (CDM) or research staff member who did not observe the infant cognitive or play assessments.

In the initial timeline follow-back interview administered at recruitment in the MOU, the mother was asked about her drinking on a day-by-day basis during a typical 2-week period around the time of conception, with recall linked to specific times of day activities. If her drinking had changed since conception, she was also asked about her drinking during the past 2 weeks and when her drinking had changed. At the follow-up antenatal visit in our laboratory, the mother was asked about her drinking during the previous 2 weeks. If there were any weeks since the recruitment visit when she drank greater quantities, she was asked to report her drinking for those weeks as well. At the 1-month postpartum visit, the mother was asked about her drinking during a typical 2-week period during the latter part of pregnancy, as well as her drinking during any weeks during that period when she drank greater quantities. Volume was recorded for each type of alcohol beverage consumed and converted to oz of absolute alcohol (AA) by using the weights proposed by Bowman, Stein,

[1]All women who reported drinking during pregnancy were advised that stopping or reducing their drinking would reduce the risk to their baby. After the high incidence of maternal alcoholism was recognized, an intervention was implemented in which both drinking and nondrinking mothers were invited to participate in a home visitor program run by the Parent Centre, a nonprofit organization in the community, shortly after being recruited into the study. The program involved meeting with a home visitor 1 to 2 times/week during pregnancy and for 6 months postpartum. The home visitors were trained to use motivational interviewing techniques to support and encourage the mothers to talk about their use of alcohol and other stresses in their everyday life, with the aim of helping the mother find ways to reduce her alcohol intake or be referred for treatment for alcoholism. The home visitors were supervised by and met weekly with a licensed psychologist and/or a senior social worker at the Parent Centre. Training of the supervisors and home visitors was conducted in collaboration with Stephen Rollnick, Ph.D., and Mireille Landman, M.A., with funding from NIH/NIAAA (R01-AA09524, Administrative Supplement to S. Jacobson). Arrangements were made with the Psychiatry Department at Groote Schuur Hospital for referral for treatment of severe depression and/or alcohol abuse or dependence, if requested by the mother.

and Newton (1975; liquor—0.4, beer—0.04, wine—0.2). Six summary measures were constructed–average oz AA/day at conception, AA/day averaged across pregnancy, AA per drinking day (quantity per occasion) at conception and across pregnancy, and frequency of drinking at conception and across pregnancy. Maternal report of drinking during pregnancy was validated by examining fatty acid ethyl esters of alcohol in meconium specimens obtained from a subsample of newborns who participated in this study (Bearer et al., 2003). In addition to the quantitative alcohol interview, alcohol abuse and/or dependence were diagnosed based on DSM-IV criteria using the alcohol module of the Diagnostic Interview Schedule (DIS). Each mother was also asked at both the antenatal and postnatal interviews how many cigarettes she smoked per day and how frequently (days/month) she used illicit drugs, including cocaine, marijuana, and methaqualone ("mandrax"), during pregnancy.

Birth weight and head circumference were obtained from hospital medical records (see Carter et al., 2005). Gestational age (GA) was calculated from early pregnancy ultrasound examination or expected date of confinement, when ultrasound data were not available.

Assessments during Infancy

Complexity of play was assessed at 13 months using the procedure developed by Belsky et al. (1984) and adapted by Jacobson et al. (1993). Ten minutes of spontaneous play with a set of toys similar to those used by Belsky et al. (1984) were videotaped and described simultaneously by a trained observer on audiotape. Suggestion and modeling were then used to elicit progressively higher levels of play than those spontaneously exhibited by the infant. Trained scorers coded the tapes on a 14-level complexity-of-play scale to reflect the following developmental sequence. Initially, play with objects consists of undifferentiated behaviors, such as, simple mouthing and banging. The infant then begins to demonstrate knowledge of the functions of real objects by gesture (enactive naming). Infants then enact/pretend everyday activities involving the object (raising cup to lip; stroking own hair with a miniature brush), and later pretending becomes decentered, so that the infant applies pretend schemes to dolls and self, for example, feeds doll or self with spoon or pushes a car on the floor while making a car noise. Play is then integrated into sequences and later the infant is able to imbue seemingly meaningless objects with meaning (substitution). Following Belsky et al. (1984), spontaneous play was defined as the highest level of play observed during the initial 10 minute free play period; elicited play, as the highest level elicited by the examiner.

Quality of parenting was evaluated at 12 months on the Home Observation for Measurement of the Environment (HOME; Caldwell & Bradley, 1979), which combines a semi-structured maternal interview with observation of mother-infant interaction. The interview was conducted by an examiner who was blind with respect to the play assessment. The validity and sensitivity of this measure as an indicator of socio-environmental influences on development have been demonstrated by evidence that it explains significant variance in childhood cognitive functioning over and above that attributable to socioeconomic status (SES) and maternal education (Bradley & Caldwell, 1984; S. Jacobson & Jacobson, 1992; S. Jacobson, Chiodo, & Jacobson, 1999). The HOME is divided into six subscales, parental responsivity, acceptance of the child, organization of the environment, appropriate play materials, parental involvement, and variety in daily stimulation. Because it can be dangerous for research staff to visit the neighborhoods where these families live, the Infant-Toddler HOME was given using a script developed by one of the authors (SJ) for its administration in the laboratory. Barnard, Bee and Hammond (1984) have found that the predictive validity of a laboratory-administered HOME was as good as that of in-home assessments. In addition, we have previously reported that the correlation of the Bayley MDI with the 12-month HOME administered in the laboratory to our Detroit cohort was midway between those reported by Siegel (1984) and Barnard et al. (1984), both of whom used in-home administration at 1 year (Jacobson et al., 1993).

Maternal depression was assessed prenatally and at 6.5 and 12 months postpartum on the Beck Depression Inventory (BDI), a 21-item measure that is highly correlated with in-depth clinical assessments of depression (Beck & Steer, 1979). A BDI score of 16 or above is considered indicative of moderate to severe depression. Given that BDI scores at these three time points were highly intercorrelated (median $r = .70$) and multiple measures are likely to provide a more reliable indicator, the average of the three BDI assessments was used in the analyses presented here. The major depression module of the Structured Clinical Interview for DSM-IV (SCID) was also administered. SES was assessed on the Hollingshead Four Factor Index (Hollingshead, 1975), which is based on occupational status and educational attainment of both parents and has been shown to be related more strongly to early child cognitive functioning, than other standard indices of SES (Gottfried, 1985). Maternal nonverbal intellectual competence was assessed on the Raven (1996) Progressive Matrices. Life stress was assessed on the Life Events Scale (Holmes & Rahe, 1967), on which the mother rated any of 43 listed events she experienced over the preceding year on a 7-point scale in terms of how stressful she found each event. Postpartum maternal alcohol consumption was assessed at 13 months in terms of oz AA/day, based on the mother's timeline follow-back report regarding her alcohol consumption over a typical 2-week period during the previous year.

5-Year Assessments

In September 2005, we organized a clinic at which each child was independently examined for growth and FAS anomalies using a standard protocol (Hoyme et al., 2005) by two U.S.-based, expert FAS dysmorphologists, who subsequently reached agreement (Jacobson et al., 2008). FAS is characterized by a distinctive craniofacial pattern of dysmorphic features (short palpebral fissures, thin upper lip, flat or smooth philtrum), small head circumference; and growth retardation. Partial FAS (PFAS) is diagnosed when there is a history of heavy maternal drinking during pregnancy, the presence of two of the three key alcohol-related facial anomalies, and at least one of the following—small head circumference, growth retardation, or cognitive and/or behavioral dysfunction. Inter-rater reliability between these dysmorphologists was high on their assessments of all dysmorphic features, including palpebral fissure length and philtrum and vermilion ratings based on the Astley and Clarren (2001) rating scales (r's = 0.80, 0.84, and 0.77, respectively). There was also substantial agreement between these dysmorphologists and a Cape Town-based dysmorphologist (median $r = 0.78$), who evaluated 11 children who could not be scheduled for the clinic.

At 5 years ($M = 5.1$ yr, SD = 0.2), 102 of the children were administered the Junior South African Individual Scales (JSAIS; Madge et al., 1981), a standardized IQ assessment similar to the Wechsler Intelligence Test for Children. The examiners who administered the JSAIS were blind with respect to maternal alcohol consumption history and, except in the most severe cases, FAS diagnosis. In this paper we examine the relation of infant symbolic play to the four verbal JSAIS subtests administered in this study: Vocabulary, Word Association, and Picture Riddles, which comprise the JSAIS Verbal IQ score, and Digit Span, which assesses verbal working memory.

Data Analysis

Before analysis, all variables were checked for normality of distribution. AA/day at conception, during pregnancy, and postpartum were positively skewed (skew > 3.0) and were normalized by means of log (X +1) transformation. The relation of each of nine socio-environmental measures to spontaneous and elicited play was examined initially using Pearson correlation analysis. The two endpoints were then each examined in a multiple regression analysis based on the socio-environmental measures that were at least weakly ($p < .10$) correlated with them

Pearson correlation was used to examine the relation of the six measures of prenatal alcohol exposure to spontaneous and elicited play. The endpoints were then each examined in a multiple regression analysis in relation to AA/day during pregnancy and the socio-environmental measures that emerged as potential confounders (i.e., related to outcome at $p < .10$) in the previous regression analyses. Because neither measure of symbolic play was related to gender or maternal smoking or illicit drug use during pregnancy (all p's > .20), none of these measures was considered a potential confounder of the effects of prenatal alcohol exposure on these endpoints (J. Jacobson & Jacobson, 1996). Pearson correlation was used to examine the association between infant symbolic play and the four verbal JSAIS subtests administered at 5 years. The relation of infant symbolic play to 5-year FASD diagnosis was examined using analysis of variance. While spontaneous play was unrelated to birth size and GA, elicited play was related to birth weight ($r = .27$, $p < .01$), head circumference ($r = .22$, $p < .05$), and GA ($r = .20$, $p < .05$). Each of those measures was entered into the second step of the multiple regression analysis of elicited play on alcohol exposure group to determine whether it reduced the impact of prenatal alcohol on play, which would indicate mediation of the fetal alcohol effect.

Results

Sample Characteristics

Demographic and background characteristics are summarized in Table 1. Heavy alcohol users did not differ on SES, age at delivery, or performance on the Raven test of nonverbal cognitive competence. However, they were less educated, less likely to be married, reported a greater number of stressful life events, and scored lower on the HOME Inventory than abstainers/light drinkers. Heavy drinkers also reported more depressive symptoms, with 54.5% meeting criteria for moderate to severe depression on the BDI, as compared to 19.5% of the abstainers/light drinkers, X^2 (1) = 12.82, $p < .001$, and 27.1% met criteria for major depression on the SCID as compared to 15.4% of the control mothers, X^2 (1) = 1.86, n.s.

Eighteen (16.8%) infants were born preterm (GA < 37 weeks), but only one heavy exposed infant was born at < 32 weeks. There were no significant between-group differences for GA (Table 1). By contrast, birth weight was lower and head circumference smaller for newborns in the heavy exposed group than those in the abstaining/light drinking control group, as expected for fetal alcohol exposure (Jacobson et al., 1994). Only one infant in the control group weighed less than 2500 g, as contrasted to 16 among the exposed infants.

Alcohol and drug use during pregnancy—The Cape Town mothers who drank at time of conception consumed an average of 4.2 standard drinks per day, and alcohol consumption across pregnancy averaged 2.8 standard drinks per day (Table 1). However, these women did not drink on a daily basis but concentrated their drinking on the weekends, consuming an average of as many as 6–8 drinks per occasion at conception and during pregnancy. Among the drinkers, more than half were alcohol abusing or dependent: 16.7% met criteria for alcohol abuse and 39.4%, for alcohol dependence. Eleven women (10.3%) reported using marijuana; the median frequency for these women was 1.7 days/week (range = .03–5.2). Only two women reported using methaqualone (mandrax) during pregnancy, and none reported cocaine use. A large majority (69.2%) of the women smoked cigarettes, with almost a quarter (23.4%) smoking an average of 10 or more cigarettes per day.

Symbolic play—No significant gender differences were found for spontaneous or elicited play (both p's > .20). Mean spontaneous play level ($M = 5.8$, SD = 3.0) corresponded to pretense behavior directed towards self, such as raising cup to one's lip or stroking one's hair with a miniature brush. Consistent with Belsky et al. (1984), the infants demonstrated

more complex play in response to elicitation by the examiner, the mean response in Cape Town (M = 12.0, SD = 3.7) consisting of imitation of a series of single pretense acts, such as drinking from a cup, followed by giving the doll a drink from the cup. Performance on both play measures was similar to that reported in the Detroit cohort (Jacobson et al., 1993) and for a middle class sample assessed at 1 year (Tamis-LeMonde & Bornstein, 1990).

FASD diagnosis at 5 years—Twenty-nine (43.9%) children born to the 66 heavy drinking mothers met criterion for FAS or PFAS, while the other 37 heavy exposed children did not have the facial or growth deficits and were, therefore, potentially ARND. Severity of FAS diagnosis was related to alcohol use at conception, $F(2,99) = 30.21$, $p < .001$, and during pregnancy, $F(2,99) = 36.96$, $p < .001$, with mothers of children with FAS/PFAS reporting drinking on average about 7–8 drinks/occasion about 2 days/week at conception and during pregnancy. Heavy drinkers whose children were not dysmorphic drank about the same quantity per occasion at both times but reduced their frequency of drinking to about 1 day/week during pregnancy, which was significantly less frequent than the mothers of the FAS/PFAS children, $p < .05$. By contrast, women recruited for the control group abstained or drank very little alcohol during pregnancy (Ms = 0.1 standard drinks/occasion at conception and 0.2 drinks/occasion across pregnancy), both on no more than two occasions during the entire pregnancy. As expected, there was a significant between-group difference in IQ with children with FAS/PFAS scoring more poorly than abstainers/light drinkers and heavily exposed nonsyndromal children, Ms (SDs) = 79.0 (8.3) < 85.9 (11.1) and 84.3 (9.7), F (2, 98) = 4.08, $p < .025$.

Relation of Socio-environmental Characteristics to Symbolic Play

The relation of nine maternal socio-demographic and socio-emotional characteristics to spontaneous and elicited play is shown in Table 2. Among these measures, the HOME and family SES were the strongest predictors of both measures of symbolic play. Maternal education, depression, and postpartum drinking were also related to elicited play. By contrast, maternal life stress, nonverbal cognitive competence, and age at delivery did not relate to either measure of symbolic play.

Spontaneous and elicited play were each examined in a multiple regression analysis based on the socio-environmental measures that were at least weakly ($p < .10$) correlated with them. The first regression showed that both quality of caregiving as measured on the HOME and family SES appear to independently facilitate more optimal spontaneous play, Multiple $R^2 = .13$, $p < .001$. By contrast, the HOME Inventory was the only measure that was significant in the elicited play regression, Multiple $R^2 = .17$, $p < .005$, suggesting that the influence of the other socioenvironmental factors—SES, marital status, and maternal education, depression, and postpartum drinking—on elicited play is mediated via the influence of these factors on the quality of parenting and intellectual stimulation provided by the parent. On the HOME subscales (Table 3), performance (spontaneous play) was strongly associated with organization of the environment, play materials, and parental involvement. Elicited play was associated with parental responsivity, play materials, parental involvement, and variety of stimulation.

Relation of Prenatal Alcohol Exposure to Symbolic Play

We initially examined the correlations of average maternal alcohol consumption per day, quantity per occasion, and frequency of drinking days at conception and across pregnancy with levels of symbolic play (Table 4). All six measures of prenatal alcohol exposure were inversely correlated with level of play. The strongest association was between overall alcohol intake averaged across pregnancy (oz AA/day) and elicited play.

The effect of drinking during pregnancy on symbolic play was tested by regressing each of the symbolic play measures on oz AA/day during pregnancy and the potential confounding socioenvironmental variables related to each play measure at $p < .10$ in the regressions shown in Table 2. When spontaneous play was examined in relation to pregnancy drinking, HOME Inventory, and SES, the effect of prenatal alcohol was no longer significant, while the relations with quality of parenting and family SES continued to be evident (Table 5). This finding indicates that the correlation of spontaneous play with prenatal exposure was actually attributable to the poorer socioeconomic circumstances and less optimal intellectual stimulation provided by the drinking mothers. By contrast, in the elicited play regression, the associations of prenatal alcohol and quality of parenting were both significant, indicating that each of these factors independently influenced the early development of elicited play. After the two infants who were exposed to methaqualone during pregnancy were excluded, the effects remained virtually unchanged. Thus, neither of these findings can be attributed to maternal smoking and illicit drug use during pregnancy because, as noted above, these exposures were not related to either infant play measure (Jacobson & Jacobson, 1996). Birth weight and head circumference were highly correlated ($r = .71$) and could not both be entered into the regression at once due to multicollinearity. Regression analyses indicated that, unlike GA, birth weight and head circumference each partially mediated the effects of prenatal alcohol exposure on elicited play. When birth weight was added to the regression of elicited play on alcohol exposure, the standardized regression coefficient for exposure was reduced from −.22 to −.17, indicating that birth weight partially mediated the effect. Similarly, when head circumference was added to the regression, the standardized regression coefficient for exposure was reduced from −.22 to −.19, indicating partial mediation.

Relation of the Infant Symbolic Play Measures to Verbal Competence at Age 5 Years

Table 6 shows the correlations of the two symbolic play measures with the four verbal subtests from the Junior South African Intelligence Scales, which were administered at age 5 years. Spontaneous play was related to one verbal subtest but unrelated to the others. Although the relation of elicited play to verbal IQ and its constituent subtests fell short of statistical significance, elicited play predicted poorer verbal working memory on the Digit Span test, confirming that this measure of the development of symbolic play competence in infancy may provide an early indicator of verbal working memory ability or early executive function.

Relation of Infant Symbolic Play to FASD

The relation of symbolic play in infancy to FASD diagnosis at 5 years was examined using analysis of variance (Table 7). Whereas spontaneous play was unrelated to diagnosis, mean elicited play levels were lower for infants subsequently diagnosed with FAS/PFAS and also for the nonsyndromal heavily exposed infants when contrasted to the abstainers/light drinkers. Post hoc tests showed that elicited play scores were lower for both the FAS/PFAS ($p < .01$) and other heavy exposed ($p < .025$) infants compared with abstainers/light drinkers.

Discussion

This study confirms the association between fetal alcohol exposure and elicited play in this heavily exposed Cape Coloured population that was first reported in a moderately exposed, inner city African American cohort in Detroit. In both the Cape Town and Detroit cohorts, the observed relation of prenatal alcohol exposure to spontaneous play was attributable to being reared in a less optimal social environment. By contrast, in both cohorts the association with elicited play remained significant after controlling for these influences, indicating an impact of prenatal alcohol that is independent of the adverse effects associated

with being raised in a less optimal social environment. The effect of prenatal alcohol exposure on elicited play suggests that this exposure is associated with a delay in the development of competence as the infant proceeds through the stages of mastering symbolic play. Alternatively, prenatal alcohol exposure may interfere specifically with the child's ability to model his/her behavior to that demonstrated by the examiner, a capacity that plays an important role throughout early cognitive development. The replication of these findings in a sample of children whose ethnic and socio-cultural background differs markedly from the original Detroit cohort and the distinct effects of the alcohol exposure and the environment on these two forms of symbolic play attests to the robustness of these effects.

These data also demonstrate that the social environment plays a critical role in the rate at which the infant progresses through the stages of both performance and underlying competence in mastering symbolic play, as indicated by both the spontaneous and elicited play measures. Bradley et al. (1989) distinguish between process and status environmental factors in relation to mental development. Process environmental factors are those aspects of the environment that are directly experienced in interaction with caregivers and others; whereas the benefits of status factors, such as financial resources, are experienced more indirectly. The HOME, representing parental stimulation provides an example of a process factor, and SES, a more general measure, would be considered a status factor. Although spontaneous and elicited play were both associated with process (HOME) and status (SES) factors, elicited play was more strongly associated with the process measure. When compared with spontaneous play, elicited play was more strongly related to three of the HOME subscales, parental responsivity, play materials, and parental involvement, suggesting that attention to providing age-appropriate play materials and responsiveness to the infant's initiations and needs plays a particularly important role in the early development of competence in symbolic play. It was also of interest that, by contrast to the direct measures of quality of intellectual stimulation provided by the HOME, other maternal characteristics, including nonverbal intellectual competence and life stress, had little apparent impact on the early development of symbolic play.

Bradley et al. (1989) examined the relation between the environment and infant development in six North American cohorts using measures that included SES, ethnic group, maternal education and the HOME. The mean HOME scores at 12 months of age ranged from 27.9 to 36.5, with a total sample mean of 32.5. The mean of 30.9 for the Detroit sample was only slightly lower than in the other US cohorts, but the mean of 26.5 in our Cape Town sample was substantially lower. Thus, the infants in Cape Town appear to have been exposed to markedly less optimal parenting on the average than that experienced in the economically disadvantaged US samples, although there was a wide range of scores. Despite the difference, the subtests of the HOME most closely related to infant development in the U.S. studies, parental responsivity, play materials, parental involvement and variety were the same as those found to be conducive to elicited play development in Cape Town. These data are consistent with Richter and Grieve's (1991) emphasis on the importance for cognitive development of the caregiver's active structuring of the infant's experience in the context of African poverty.

Our previously reported Detroit finding that infant symbolic play is predictive of early school-age Verbal IQ (S. Jacobson et al., 1996) suggests that this form of play is an important precursor of language development. In the Cape Town cohort, elicited play predicted better verbal working memory performance on the Digit Span task at 5 years and its relation to Verbal IQ fell short of statistical significance. Moreover, children subsequently diagnosed with FAS/PFAS diagnosis performed significantly more poorly on elicited play than the abstainers/light drinkers. Given the difficulty of diagnosing and identifying FAS/PFAS in infancy, elicited play may, therefore, provide a useful early

indicator of which children are at risk for the deficits in verbal working memory often found in fetal alcohol exposure and which infants are at risk for FASD (S. Jacobson et al., 2004; Mattson, Riley, Gramling, Delis, & Jones, 1998; Russell, Czarnecki, Cowan, McPherson, & Mudar, 1991). The differences in the findings relating to the spontaneous and elicited play measures illustrate the difficulty in determining which alcohol exposed infants are adversely affected. Given that the effect of prenatal alcohol on spontaneous play was not significant after adjustment for the HOME and SES, the data suggest that infant play observed casually by a clinician will not be relevant for assessing fetal alcohol-related impairment, whereas a direct assessment of the infant's capacity to imitate symbolic play behavior modeled by the examiner might well be highly informative. Identification of neurobehavioral biomarkers is particularly important in infancy when the facial dysmorphology is difficult to distinguish in order to facilitate determination of affected infants most in need of early intervention.

A limitation of human fetal alcohol exposure studies is they that are by necessity correlational, and all possible confounding variables cannot be controlled. However, replication of previous findings relating prenatal alcohol exposure to symbolic play in infants in two independent, cross-culturally distinct populations suggest that this is a robust finding. The alcohol information in this study relies on self-report from the mothers. The self-reports based on timeline follow-back interviews enabled us to examine continuous measures of alcohol exposure, which were prospectively obtained during pregnancy by trained interviewers, an approach that we have previously shown to be more valid than retrospective self-report in predicting neurobehavioral outcomes (Jacobson et al., 2002). The validity of the self-report was further confirmed by findings showing significant correlations between maternal self-report of drinking during pregnancy and fatty acid ethyl esters of alcohol in meconium specimens obtained from a subsample of newborns from this cohort (Bearer et al., 2003). Diagnoses of FAS at 5 years also showed a dose-dependent relation between the maternal reports obtained during pregnancy and the subsequent severity of the diagnosis (Jacobson et al., 2008), thereby further strengthening the validity of the maternal self-report measure.

In this cohort of infants from an urban socio-economically disadvantaged community in Cape Town characterized by heavy prenatal alcohol use, it is of particular interest that competence in symbolic play was associated independently with both alcohol exposure *in utero* and quality of parenting. These data suggest that even infants whose symbolic play development is adversely affected by prenatal exposure may benefit from input from a responsive caregiver who uses play materials to provide appropriate stimulation. Promotion of infant development should, therefore, encompass both the prevention of alcohol abuse in pregnant women and early developmental intervention through parental stimulation.

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Table 1

Sample characteristics by exposure group

	Prenatal alcohol exposure groups		
	Heavy drinkers (*N* = 66)	**Abstainers/light drinkers (*N* = 41)**	***t* or χ^2**
Maternal characteristics			
Socioeconomic status [a]	18.9 (8.3)	21.4 (7.6)	1.53
Age at delivery	27.2 (7.2)	27.9 (6.2)	0.48
Parity	2.3 (1.5)	1.9 (1.0)	1.82†
Years of school completed	8.0 (2.5)	9.8 (1.8)	3.87***
Married (%)	22.7	48.8	7.80**
Raven score [b]	27.4 (10.7)	30.0 (8.4)	1.32
Depression [c]	18.4 (11.2)	10.7 (9.9)	3.61***
Life stress [d]	21.7 (20.6)	12.1 (12.9)	2.95**
HOME score [e]	24.6 (6.2)	29.6 (5.3)	4.33***
Daily average (oz AA)			
At conception	1.4 (1.8)	0.007 (0.03)	6.34***
During pregnancy	0.9 (1.1)	0.008 (0.03)	6.44***
Average per drinking day (oz AA)			
At conception	3.8 (2.9)	0.07 (0.3)	10.38***
During pregnancy	3.1 (2.1)	0.1 (0.4)	11.15***
Number of drinking days/week			
At conception	2.1 (1.7)	0.04 (0.2)	9.90***
During pregnancy	1.4 (1.2)	0.04 (0.2)	9.13***
Cigarettes/day	6.4 (5.6)	4.1 (6.2)	1.95*
Marijuana (days/wk)	0.3 (0.9)	0.1 (0.5)	0.96
Infant characteristics			
Gender (% male)	54.5	51.2	0.74
Gestational age (wk)	38.6 (2.6)	39.1 (1.6)	1.41
Birth weight (g)	2765.0 (645.7)	3203.1 (410.1)	4.29***
Head circumference (cm)	32.75 (2.3)	33.3 (1.4)	2.25*

Values are *M* (SD) or %.

$^{\dagger}p < .10$

$^{*}p < .05$

$^{**}p < .01$

$^{***}p < .001$

[a] Hollingshead Scale.

[b] Raven Progressive Matrices.

[c] Beck Depression Inventory.

[d] Life Events Scale.

[e] Home Observation for Measurement of the Environment

Table 2

Relation of maternal socio-demographic and socio-emotional measures to symbolic play (N = 107)

	Spontaneous play (Performance)		Elicited play (Competence)	
	r	**β**	***r***	**β**
SES	.28**	.22*	.27**	.16
Age at delivery	−.01	---[a]	−.05	---[a]
Education	.12	---[a]	.20*	.02
Marital status	−.04	---[a]	−.19†	.05
Raven	.01	---[a]	.06	---[a]
Beck depression	−.13	---[a]	−.21*	−.03
HOME	.29**	.23*	.35***	.25*
Life stress	−.01	---[a]	−.02	---[a]
Postpartum oz AA/day	−.11	---[a]	−.20*	−.07

[a] NA

† $p < .10$

* $p < .05$

** $p < .01$

*** $p < .001$

Table 3

Relation between HOME subscales and symbolic play (N = 107)

	Responsivity	Acceptance	Organization	Play Materials	Involvement	Variety
Spontaneous Play	.16	.09	.26**	.23*	.29**	.20*
Elicited play	.26*	.18†	.13	.37***	.31**	.21*

Values are Pearson r 's.

† $p < .10$

* $p < .05$

** $p < .01$

*** $p < .001$

Table 4

Relation of prenatal alcohol exposure to infant play (N = 107)

	Average alcohol/day		Drinks/occasion		Frequency	
	At conception	Across pregnancy	At conception	Across pregnancy	At conception	Across pregnancy
Free play	−.19*	−.18†	−.22*	−.19*	−.17†	−.19*
Elicited play	−.28**	−.34***	−.28**	−.31**	−.22*	−.30**

Values are Pearson's *r's*.

† $p < .10$

* $p < .05$

** $p < .01$

*** $p < .001$

Table 5

Regression analysis of infant play on prenatal alcohol exposure and HOME (Quality of parenting) (N = 107)

	Absolute alcohol/day		HOME		SES	
	r	**β**	***r***	**β**	***r***	**β**
Spontaneous play	−.18†	.00	.29**	.23*.	.28**	.22*
Elicited play	−.34***	−.22*	.35***	.24*	---[a]	--- [a]

[a] NA

† $p < .10$

* $p < .05$

** $p < .01$

*** $p < .001$

Table 6

Relation of symbolic play to verbal competence subtests from the Junior South African Intelligence Scales (N = 102)

	Spontaneous play (Performance)	Elicited play (Competence)
Verbal IQ	.10	.16†
Vocabulary	.03	.13
Word Association	.01	.16†
Picture Riddles	.19*	.13
Digit Span	.07	.25**

Values are Pearson r.

† $p < .10$

* $p < .05$

** $p < .01$.

Table 7

Relation of infant symbolic play to FASD diagnosis at 5 years

	FAS/PFAS	Other Heavily Exposed	Abstainers/ Light Drinkers	*F* (2, 99)
Spontaneous play	6.0	5.4	6.2	0.63
	(2.9)	(3.2)	(2.7)	
Elicited play	10.7	11.4	13.5	5.85*
	(4.3)	(3.6)	(2.7)	

Values are means (standard deviation).

* $p < .005$